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LOS ANGELES 45, CALIFORNIA

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INTEROFFICE CORRESPONDENCE

TO: Louis G. Dunn

CC: Listed below

DATE: 5 March 1958

SUBJECT: Meeting with Killian Subcommittee on Space with Reference to Project Baker

FROM: F. Donovan

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Present:

Committee Members

Dr. E. M. Purcell, Chairman
Dr. H. F. York, Assistant Chairman
Dr. Hugh L. Dryden
Dr. Alan T. Waterman, Nat. Science Foundation
Dr. S. Paul Johnson
Dr. E. Piore

Presenters

Mr. William Stroud, Watson Laboratories, Signal Corps, U. S. Army
Dr. Howard Wilcox, NOTS, Inyokern
Dr. Clarence Gates and Mr. Walter Victor, JPL
Dr. R. R. Bennett, and A. F. Donovan, STL

Others present: One man, name unknown - from JPL

Summary:

It was emphasized by Drs. York, Dryden and Purcell that the decision had been made to conduct a lunar experiment on the following basis:

1. Contact with the moon of some type is to be made as soon as possible, subject to the limitations:

    a. That the contact be of real significance, and preferably of a type that the public can admire,

    b. That the contact not contaminate the moon either radiologically or biologically.

It was obviously the opinion of the Committee that the most suitable information from the standpoint of their objectives would be pictorial information, particularly on the part of the moon that cannot be observed through telescopes. The unannounced but apparent objective of Drs. Purcell, York and Dryden appeared to be to bring together in some manner the vehicle capabilities of AFBMD and STL with the lunar reconnaissance capabilities of other organizations so as to effect as early as possible visual lunar reconnaissance. It was stated several times that approval for a lunar project was

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unlikely to be given unless "significant" data can be obtained.

Two presentations of particular interest were made. The Signal Corps representative, Mr. Stroud, reported on a television package that is to be launched with the second Vanguard. This package has a total weight of 12 lbs., including batteries (which are eight out of the 12 lbs.). It has a transmitting power of one watt and includes a tape recorder and playback system. This package exists and might, with adaptation and the use of 60 ft. or better dishes on the ground, be used to obtain lunar pictures.

The second presentation was made by Dr. Wilcox of NOTS, who has developed a package which has been flown in an airplane successfully, but would require repackaging for missile use. Dr. Wilcox believes he could, with priority, provide a system qualified for missile use within three months. The weight of the system was estimated at 20 lbs. This system also used one watt and had a resolution of one milliradian.

Dr. Gates of JPL defined their two systems. The first is similar to that of Mr. Stroud's, while the alternate carries a Polaroid camera, develops the picture, and transmits it back by a simple facsimile system.

Conclusions:

In view of the significance that the Killian Committee has placed on getting "impressive" data from this experiment and the effort which was taken to arrange this meeting, it is believed to be imperative from both the practical and the political standpoints for us to review carefully the possibilities of using either the NOTS or Signal Corps television unit in the Baker program. Either one apparently would meet the weight requirements. The Signal Corps equipment could apparently be sure of meeting the time requirement, but would be marginal on performance. The NOTS system (if it works as advertised) would give much better performance, but appears more questionable from a delivery standpoint. In either case, it appears mandatory that we explore the possibilities and, if it is necessary to reject the systems, to do so only after a most thorough consideration. In parallel with this we should conduct an intensive investigation of what significant experiments might be done without a pictorial reconnaissance system.

General:

Fortunately, Dr. Bennett and I arrived on time (but unshaven) after our all night TWA sleeper seat trip. Dr. York opened the meeting. (Dr. Purcell had not yet arrived from Boston.) Dr. York stated that it had been decided to attempt a lunar mission with the objectives of:

a. Making contact of some type with the moon as soon as possible, but with the limitation,

b. That the contact be of a type that has significance such that the public can admire it.

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He next stated that in examining the kind of experiments that might be run with a lunar vehicle, it appears that the most significant would be some kind of visual reconnaissance, and that therefore they had arranged to call in the people from the Signal Corps and NOTS who had been working on systems of this type, so that they could present their state of progress to JPL and STL who have been developing vehicles. It was his hope that he could thereby induce some interactions that would result in an earlier accomplishment of lunar experiments of significance. Mr. Stroud of the Signal Corps Laboratory was first asked to describe his system.

Mr. Stroud began by stating that their visual scanner is in the form of existing hardware qualified for missile flight, and that units are now at Cape Canaveral for launch in the next Vanguard. This came as somewhat of a surprise to me, as I did not realise that visual reconnaissance was included in the early Vanguard program. The first system is a simple one including two sensors, one pointed ahead at approximately a 45° angle with reference to the spin axis, and one behind, as shown in Fig. 1. The spin of the satellite is used as a means of scanning. The specifications for Vanguard were telemetering time of one minute to transmit 50 minutes of pictures,* a signal to noise ratio of at least one for one watt, and resolution of a five-mile square at 300 miles altitude. Transmission is to be on 108.03 megacycles. To accomplish this, they used optics with an F 0.7 lens with a 53 mm. aperture, giving approximately a one degree field of view, and a one watt transmitter with a 15 kc bandwidth. Optimum spin rate is 30 to 40 rpm., and they have a dynamic range of approximately 100:1. The complete unit sits in a can, as shown in Fig. 2, which is

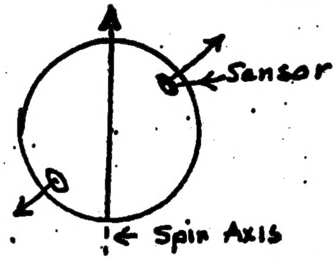

Fig. 1

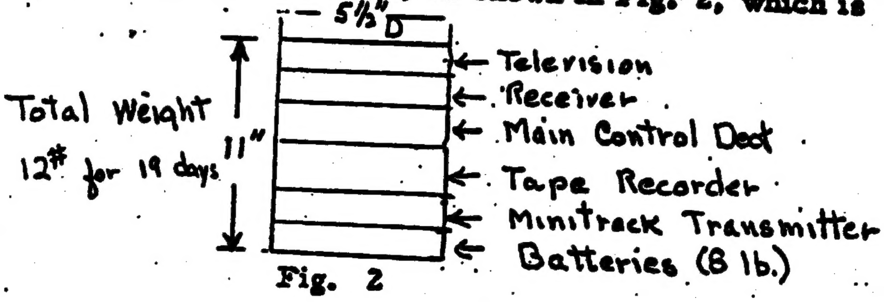

Fig. 2

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*This fast playback is necessary because of the short time the satellite is within range of a single ground station.

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5 1/2" in diameter and 11" long, with a total weight of 12 lbs. This unit has an active life of 19 days. As shown in the sketch, the upper part contains the television receiver. The next section has the electronic receiver components, and is followed by a main deck with miscellaneous electronic items, a tape recorder package for storage of the received data, then a Minitrack transmitter and, finally, in the bottom, 8 lbs. of batteries. The tape recorder plays back at 50 times the speed at which it receives the information. The Signal Corps has objectives to develop by the end of this year a unit weighing not more than 30 lbs., good for 60 days, that will give one mile resolution at 500 miles, using the same general approach. The key problem in achieving this, they believe, is spin stabilization and orientation, and they estimate the additional system to produce the proper spin stabilization and orientation at 20 lbs. additional. This advanced unit will use a 120 kc. bandwidth and will weigh from 20 to 30 lbs., plus stabilization unit, and will be able to give 5 watts output from the moon in four minute bursts for a period of several days. Mr. Stroud assumed a Minitrack antenna on the ground which he defined as giving 12 db. gain. Batteries for these systems are estimated to give 50 watt-hours output per pound. Some further possibilities of the Signal Corps system came up later during the discussion and will be treated subsequently in this memorandum.

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The next presenter, Dr. Howard Wilcox of the Naval Ordnance Test Station, described a somewhat similar system using the spin of the vehicle at approximately 5 revolutions per second, but with a one milliradian, or 0.175°, resolution. The NOTS system was designed for a 10 kc band pass, a one watt transmitter to give a 4:1 signal to noise ratio at 3,000 miles, and uses a lead sulphite detector operating in the range from 2.1 to 2.7 microns. Some discussion arose as to the suitability of this optical band, but Dr. Wilcox claimed to have obtained pictures with good resolution of the earth using the system when flown in airplanes. Dr. Wilcox stated that they had worried about nutation of the vehicle, and had designed a damping antenna with spaghetti to eliminate nutations. It was Dr. Wilcox's opinion that he could make a unit suitable for use in a missile available within three months. To be specific, I asked him if he could qualify it for 10 g from 20 to 2,000 cycles in this time period. It was his opinion that he readily could. The gross weight for his unit he estimated at 20 lbs. It was obvious from Dr. Wilcox's discussion that he was not as far into detailed hardware as Mr. Stroud of the Signal Corps, but he also seemed to have considerably more confidence in his ability to solve the problems of producing a few units in a short time scale if given high priority assignment. It is my impression that Mr. Stroud is over-conservative. Dr. Wilcox is perhaps overly optimistic. A careful examination of both operations would be necessary to arrive at a realistic evaluation of the possibilities.

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Following the presentations by Mr. Stroud and Dr. Wilcox, Dr. York asked me to present what we thought we could do with a vehicle, and what our concepts were of the instrumentation. After some hemming and hawing and some remarks by Dr. York that this information was to be treated as highly classified, I stated that we believe we could put 30 lbs. in a satellite orbit around the moon during the fall of this year, and that we were interested in what equipment we might obtain to be delivered by 1 June 1958. Also, we obviously would be interested in anything that we might get later this year. I also stated that beginning about the first of next year we expected to have payloads of 100 lbs. Upon questioning with respect to miss distance from the moon, Dr. Bennett advised that a one sigma value for orbiting the moon was approximately 2,000 miles. It was stated that the satellite trajectory would be accomplished with a retrorocket, but the details of the procedure, the trajectory, etc., for doing it were not discussed. It was stated that we planned to include a simple telemetering transmitter, transmitting minimum data, perhaps measurements of the moon's magnetic field, and that we hoped to obtain other significant data by observing the trajectory of the satellite. This led to some discussion as to whether the moon's magnetic field could be measured, which concluded essentially with agreement by the Committee that it might be done by a simple induction type magnetometer. The problems of getting moon mass data and other data by observing the satellite orbit were discussed also, but no conclusive agreement was reached as to whether the satellite orbit could be tracked accurately enough to obtain significant data. I re-emphasized that in the initial experiments we are making every attempt to keep it as simple as possible to maximize the probability of success, and were reluctant to introduce television scanning systems or equivalent devices of a low probability of success. Dr. York likewise kept re-emphasizing, as did Dr. Dryden, and to a lesser extent Drs. Waterman and Purcell, the very great significance of bringing back some pictorial information, particularly of the other side of the moon. A lunar satellite of the types we are considering, of course, is particularly advantageous for obtaining exactly this type of information, since it gives the opportunity on repeated passes of acquiring such data. Hence, the Committee members were not readily dissuaded from the concept that we should at least attempt to get visual data, and hinted rather broadly that they felt experiments that did not attempt this objective would have great difficulty in achieving final approval.

The next presentation was made by JPL, the first part being given by Dr. Clarence Gates. Dr. Gates advised that they expected to have a 15 lb. payload capability during what turned out in later discussion to be the last three months of 1958, a 100 lb. payload capability beginning in January 1959, and a 300 to 400 lb. capability at some later unspecified time. Subsequent discussion disclosed that it was proposed to achieve the 15 lb. capability by adding the three solid, spun stages used in launching the Explorer to the Jupiter. The total vehicle is called Juno. The 100 lb. capability is to be obtained with more advanced solid propellant stages, and no definition was given as to how the 300 to 400 lb. capability could be realized. The 15 lb. vehicle, upon subsequent discussion, appeared to be

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primarily a test vehicle to develop guidance techniques to be used later with the 100 lb. payload system. The reconnaissance system, which I gathered from the subsequent discussion was proposed for use with the 100 lb. vehicle, is pictured in Fig. 3. Basically a 30° cone angle or

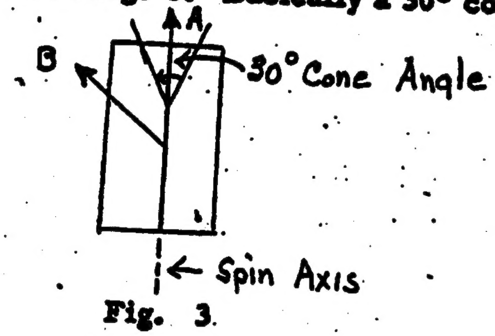

Fig. 3

30° slit system looks out at (A) perpendicular to the spin axis and sees the earth and the sun at each revolution. When the information from these two sources is suitable, a second system looking out at (B) operates to look at the moon. To accomplish this, the final stage is slowed down in rotation to one cycle per second, or less. They have proposed providing one receiving station at JPL, one in the Philippines and one in Algeria. Dr. Gates expressed some concern about the suitability of a dish in England because of the high latitude. He stated that equatorial dishes would be considerably better. He also stated that they wished to obtain an equatorial launch site as early as possible in order to minimize the error in getting into the plane of the moon's orbit. Dr. Gates is concerned about the launch time as they did not deem it feasible during this year to introduce a system into their launcher to correct for not launching at exactly the pre-planned time. Dr. Bennett advised that a system for doing this has been devised by STL, and is planned as part of any experiment we might do. The procedure for slowing down the spin rate of the fourth stage has not been selected, although jet vanes were mentioned as a possibility. Based on our limited studies of what might be accomplished with spun stages of Vanguard rockets on top of Thor, I personally am very skeptical that the JPL system can come anywhere near the moon. Dr. Gates mentioned one sigma distances of something like 10,000 to 20,000 miles. In the 100 lb. system proposed for the beginning of next year they proposed to have cut-offs in the fourth stage, but are still sticking to spinning for angular control of the last three stages. From our analyses the angular dispersion with this system would, I believe, result in one order of magnitude greater error than we hope to obtain from the initial Baker shots.

An alternate reconnaissance system was proposed in which a Polaroid camera would take a picture, develop it, and the picture would then be scanned by a simple scanner on a delayed time basis. Dr. Gates indicated that JPL felt such a device could be made quite simply using the Polaroid camera, together with two prisms for the scanning. The JPL hardware people were stated to be particularly enthusiastic about this approach, as it simplified the data transmission problem.

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The next part of the JPL presentation was given by Mr. Walter Victor on the electronics which might be used in their systems. The first experiment Mr. Victor proposed employs a transmitter with an output of a 100 milliwatts, a bandwidth of 10 cycles per second, and he stated that with a microlock receiver and a 60 ft. dish antenna this would give a signal to noise ratio corresponding to 17 db. for a bandwidth of 10 cycles per second. The weight of this system, including batteries, would be 6 lbs. The present band pass of the microlock receivers is one kilocycle. The interest in the Polaroid camera with scanning system is perhaps obvious from this, as it is a system that could permit reducing the data to a 10 cps bandwidth. The question was asked by Dr. York on the feasibility of using solar batteries. Mr. Stroud pointed out that solar batteries are now in use on Vanguard, but they are not suitable for power outputs of one watt or greater at the present time.

This essentially concluded the presentations, and the meeting degenerated at this point into some rather general discussions. In particular, I questioned Mr. Stroud, who seemed to have the most advanced existing hardware, on the possibilities of using his equipment. Since it has a tape recorder it appeared that the information could be stored in real time and played back in slow time to reduce the bandwidth requirements from 15,000 cps. to 6 cps. This bandwidth reduction, together with the use of 60 to 100 ft. dishes should make it possible to get an acceptable signal to noise ratio with the one watt output in the unit. Mr. Stroud agreed that this change could readily be made in his system. He was concerned about the problem of how we turned it on, but since it has a life of 19 days, this would seem more than adequate for any experiment we might run. The resolution of the moon from the mean distance of 2,000 miles would be only about 30 miles, so a very poor picture would result. Subsequently Mr. Stroud started to complain to the Committee that they expected to have equipment available for reconnaissance, but there were no vehicles. I countered that we could have vehicles needing equipment within three months. When I asked him what he could deliver in three months, he had no equipment. This degenerated to his opinion that our vehicles would not work, and my opinion that our vehicles had more chance of working than his equipment. When we got into this phase it became somewhat clearer that Mr. Stroud had been brainwashed by the Army. Dr. Wilcox of NOTS kept arguing that either he could produce equipment, or that Mr. Stroud's equipment could be adapted for our use within the three months period, given suitable priority and authorization. Dr. Gates of JPL expressed extreme skepticism of our ability to establish a satellite orbit. Since he obviously had been studying the cases where the last three stages were spun, and without retrorockets, I did not consider it appropriate to go into details of why we thought we could do it. If I had been studying it from his standpoint I would think it was impossible also, but I simply stated that with azimuth control and shut-off in the second stage, with spinning of the third stage, we thought we had a 50% chance of successfully establishing a lunar satellite on the first attempt. Dr. Bennett augmented this a little with

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some discussions to the effect that we did have a scheme for accounting for variations in the launch time (which JPL said they could not incorporate before the beginning of next year) and that we had considered extensively the problems of the time of launch, the time of the month, the accuracy requirements, capabilities, etc. Dr. Gates outlined the JPL proposed program as having the following objectives:

First experiment - Visual reconnaissance of the moon
Second experiment - Hit the moon.

I asked what had been done by the various parties on studies of means for indicating a hit on the moon. It appeared that nobody except the members of the Committee had considered it very seriously.

Dr. Purcell reported on studies he had done, indicating that about 200 lbs. was a minimum to place a permanent marker on the moon. There was little enthusiasm for a momentary flash at impact. Two limitations on hitting the moon were introduced (to my surprise) by Dr. York. The biologists in particular have indicated opposition to delivering anything to the moon which, in their terms, would contaminate it. Contamination, by their definition, includes either delivering radioactive material or germ-carrying material. The latter seems a little ridiculous, particularly in view of the supposed absence of life on the moon, but the biologists' point is that until it is definitely proven that no form of life exists on the moon, they do not wish to introduce any disturbance which might destroy it. Hence, under these conditions, experiments such as landing an atomic bomb on the moon are excluded, and presumably any vehicle to impact the moon should be sterilized biologically before launch. It was pointed out by Dr. Dryden that the Russians may not be so inhibited, but nevertheless it was the opinion of the Committee the United States would have to operate within these restrictions.

The question came up as to what constructive action might come out of this meeting. It was emphasized by Dr. Dryden that the desire of the Committee was to bring together the people building the vehicles and the people who have been developing instrumentation in the general hope that some constructive action would result. I stated that I felt the most constructive thing would be for me to arrange with both Mr. Stroud and Dr. Wilcox to visit us at a time when we could have appropriate people available to review with them the exact nature of their equipment, its possibilities and its availability. I emphasized that we would be especially interested in this review of what could be done in a hurry, that is, within approximately three months. The reaction of Stroud and Gates of JPL was that they doubted anything could be done successfully before 1959. In this case I emphasized that it may not be very important to do it at all since it is quite possible the Russians will have done it by that time.

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There was some discussion of the problem of establishing ground receiving stations, and it was generally indicated that while this is a very difficult problem in some respects, it is largely an organisational one. A number of 60 ft. dishes do exist, suitable receivers exist, the dishes are semi-production items and could be obtained, set up and put into operation within four to five months prior to a launch, and existing dishes could be adapted. The problem is complex administratively, but is not so complex technologically. At about this point the meeting broke up, it being generally agreed that everything that could be discussed had been and, after a brief discussion with Dr. Bennett, I left to catch an airplane. This commuting to Washington is hard on one!

Conclusions:

I have reached several conclusions which, in general, are only my own opinions:

1. We can expect a continuing and increasing pressure from the Killian Committee to get significant data and, if possible, visual data from our lunar experiments. They will insist that we use all possible resources for this purpose. ✓

2. The television systems of both the Signal Corps and NOTS are considerably further along than I had believed any systems were for possible application to the Baker mission. ✓

3. The Baker vehicle with its guidance and cut-off during second stage and close control of third stage impulse and its retrorocket system has a much higher probability of accomplishing a significant lunar experiment than any of the crude multistage systems postulated by JPL and Army. The STL systems for taking account of variation in launch times, for using a retrorocket to establish a satellite, or to impact, and other related detail developments appear to place us well ahead at this time of the Juno proposals. (If we do not get going shortly on a fluorine stage, however, we will be behind the eight ball by the end of 1959.)

4. We should immediately expand our studies of significant measurements that can be made by simple telemetering in order to try to define significant experiments that can be done without television to minimize opposition to an early launching.

5. It is imperative that we carefully review the possibilities of the Signal Corps and NOTS television units for application to Project Baker. To fail to do so on a positive and constructive basis would result in an enormous amount of ill will and potential opposition from the Killian Committee. I discussed this problem briefly with Dr. Bennett after the meeting, and it was his opinion it might be wise to consider carrying one of the television units in place of one of our transmitters

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so that we would have as a payload one television unit and one transmitter for tracking only. The television transmitter would also obviously serve for tracking purposes. Dr. Bennett felt it was impossible to tell from the information presented which of the two units, the Signal Corps' or NOTS', might be the more suitable for immediate applications, but that both should be explored.

I have the telephone numbers of both Mr. Stroud and Dr. Wilcox, and both have stated they would be glad to visit us upon invitation. I shall be glad to discuss what further action should be taken at your earliest convenience.

AFD:dr

Distribution:

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